

APPENDIX

Supplementary Table 1. ICD-10 diagnosis codes used to identify SCD genotypes

SCD Genotype Category	ICD-10 Codes
Hb SS	D57.00 D57.01 D57.02 D57.03 D57.09
Hb SC	D57.20 D57.211 D57.212 D57.213 D57.218 D57.219
Hb S β^{+0}	D57.40 D57.411 D57.412 D57.419 D57.42 D57.431 D57.432 D57.438 D57.439 D57.44 D57.451 D57.452 D57.453 D57.458 D57.459
Non-specific	D57.1 D57.80 D57.811 D57.812 D57.813 D57.818 D57.819

Hb SS: hemoglobin SS; Hb SC: hemoglobin SC; HB S β^{+0} : hemoglobin S β^{+0} thalassemia

Supplementary Table 2. ICD-10 diagnosis codes used to identify SCD-related comorbidities

Comorbidity	ICD-10 Codes
Cerebrovascular disease (CVD)	G45, G46, H34.0, I60, I61, I62, I63, I64, I65, I66, I67, I68, I69,
Congestive heart failure (CHF)	I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5, I42.6, I42.7, I42.8, I42.9, I43, I50, P29.0
Pulmonary hypertension (PH)	I27.0, I27.2
Renal disease (RD)	I12.0, I13.1, N03.2, N03.3, N03.4, N03.5, N03.6, N03.7, N05.2, N05.3, N05.4, N05.5, N05.6, N05.7, N18, N19, N25.0, Z49.0, Z49.1, Z49.2, Z94.0, Z99.2

Supplementary Table 3. ICD-10 diagnosis codes used to identify pain episodes

Variable	ICD-10 Codes
Pain episode	D57.0, D57.00, D57.219, D57.419, D57.819, R10.0, R10.10, R10.11, R10.12, R10.13, R10.2, R10.30, R10.31, R10.32, R10.33, R10.84, R10.9, R07.2, R07.89, R07.9, M25.50, M25.511, M25.512, M25.519, M25.521, M25.522, M25.531, M25.532, M25.551, M25.552, M25.559, M25.561, M25.562, M25.569, M25.571, M25.572, M25.579, M79.601, M79.602, M79.603, M79.604, M79.605, M79.606, M79.609, M79.621, M79.622, M79.629, M79.631, M79.632, M79.639, M79.641, M79.642, M79.643, M79.644, M79.645, M79.646, M79.651, M79.652, M79.659, M79.661, M79.662, M79.669, M79.671, M79.672, M79.673, M79.674, M79.675, M79.676, M54.2, M54.5, M54.6, N48.30, N48.32, N48.39

Supplementary Table 4. Annual number of pain episodes

Commercial		
	Median	Range
Pain Episodes Group		
Low	0.25	0.00-0.75
Average	1.22	0.75-2.00
Above Average	2.88	2.00-4.39
High	7.80	4.39-41.0
Medicare		
	Median	Range
Pain Episodes Group		
Low	0.60	0.00-1.26
Average	2.11	1.26-3.24
Above Average	4.87	3.24-7.48
High	12.8	7.49-53.0

Low Pain Episodes: lowest quartile of annual number of pain episodes; Average Pain Episodes: second quartile of annual number of pain episodes; Above Average Pain Episodes: third quartile of annual number of pain episodes; High Pain Episodes: highest quartile of annual number of pain episodes

Supplementary Table 5. Adjusted rate ratios (95% CI) of annual healthcare encounters and expenditure outcomes between lower-utilizer groups.

Commercial			
	Moderate-Util. vs. Low-Util.	High-Util. vs. Moderate-Util.	High-Util. vs. Low-Util.
Total Expenditure	4.38 (4.21-4.56)	2.62 (2.76-2.48)	11.48 (10.93-12.05)
Inpatient			
# Encounters	6.66 (5.75-7.71)	2.45 (2.69-2.22)	16.30 (14.13-18.79)
Expenditure	2.81 (2.64-2.98)	2.68 (2.83-2.53)	7.51 (7.04-8.02)
Outpatient			
# Encounters	1.85 (1.78-1.93)	1.63 (1.72-1.54)	3.02 (2.88-3.17)
Expenditure	2.90 (2.76-3.05)	2.33 (2.50-2.18)	6.77 (6.37-7.20)
Emergency Dept.			
# Encounters	2.37 (2.16-2.60)	1.63 (1.81-1.47)	3.88 (3.50-4.29)
Expenditure	2.01 (1.85-2.19)	1.70 (1.88-1.54)	3.43 (3.11-3.77)
Medicare			
	Moderate-Util. vs. Low-Util.	High-Util. vs. Moderate-Util.	High-Util. vs. Low-Util.
Total Expenditure	3.80 (3.67-3.94)	1.89 (1.98-1.81)	7.20 (6.89-7.52)
Inpatient			
# Encounters	3.31 (3.16-3.48)	1.69 (1.76-1.62)	5.59 (5.32-5.88)
Expenditure	3.30 (3.19-3.43)	1.88 (1.96-1.79)	6.20 (5.93-6.48)
Outpatient			
# Encounters	1.72 (1.64-1.80)	1.32 (1.40-1.25)	2.27 (2.15-2.40)
Expenditure	4.07 (3.81-4.35)	2.06 (2.24-1.89)	8.39 (7.73-9.11)
Emergency Dept.			
# Encounters	2.12 (1.98-2.26)	1.88 (2.03-1.74)	3.97 (3.68-4.29)
Expenditure	2.20 (2.07-2.34)	1.90 (2.05-1.76)	4.18 (3.89-4.50)

Low-Util.: bottom 50% of costs; Moderate Util.: top 25-49.9% of costs; High-Util: top 10-24.9% of costs

Supplementary Table 6. Adjusted rate ratios (95% CI) of annual healthcare encounters and expenditure outcomes between utilizer groups among Medicare-insured, by dual eligibility status

	Dual Eligible ^a		
	Super-Util. vs. Low-Util.	Super-Util. vs. Moderate-Util.	Super-Util. vs. High-Util
Total Expenditure	13.09 (12.38-13.84)	6.94 (6.62-7.28)	3.61 (3.48-3.75)
Inpatient			
# Encounters	9.34 (8.78-9.94)	5.80 (5.47-6.16)	3.28 (3.09-3.47)
Expenditure	12.39 (11.70-13.13)	6.13 (5.83-6.44)	3.18 (3.05-3.31)
Outpatient			
# Encounters	2.74 (2.53-2.97)	2.27 (2.12-2.43)	1.71 (1.62-1.81)
Expenditure	11.07 (9.83-12.47)	7.61 (6.88-8.42)	3.89 (3.59-4.22)
Emergency Dept.			
# Encounters	7.71 (6.93-8.56)	3.99 (3.65-4.37)	2.08 (1.93-2.25)
Expenditure	8.99 (8.11-9.96)	4.32 (3.96-4.71)	2.18 (2.02-2.34)
	Not Dual Eligible ^b		
	Super-Util. vs. Low-Util.	Super-Util. vs. Moderate-Util.	Super-Util. vs. High-Util
Total Expenditure	13.91 (12.39-15.61)	7.66 (6.99-8.38)	4.07 (3.79-4.38)
Inpatient			
# Encounters	7.53 (6.81-8.32)	4.94 (4.51-5.42)	3.30 (3.03-3.59)
Expenditure	13.25 (11.83-14.85)	6.23 (5.69-6.82)	3.51 (3.26-3.77)
Outpatient			
# Encounters	2.70 (2.39-3.05)	2.22 (2.02-2.45)	1.67 (1.55-1.81)
Expenditure	15.38 (12.82-18.46)	10.03 (8.68-11.59)	4.24 (3.78-4.76)
Emergency Dept.			
# Encounters	4.70 (3.94-5.61)	3.62 (3.15-4.17)	2.07 (1.84-2.32)
Expenditure	5.86 (4.92-6.97)	3.71 (3.24-4.26)	2.19 (1.97-2.45)

Low-Util.: bottom 50% of costs; Moderate-Util.: top 25-49.9% of costs; High-Util: top 10-24.9% of costs; Super-Util: top 10% of costs

^aDual eligible for Medicare and Medicaid at any point and for any duration during the study time range

^bNever dual eligible for Medicare and Medicaid at any point in the study time range

Supplementary Table 7. Adjusted rate ratios (95% CI) of annual healthcare encounters and expenditure outcomes between pain episode encounters groups among super-utilizers.

Commercial		
	Avg. Pain Episodes vs. High Pain Episodes	Ab. Avg. Pain Episodes vs. High Pain Episodes
Total Expenditure	0.87 (0.73-1.04)	0.94 (0.82-1.08)
Inpatient		
# Encounters	0.23 (0.17-0.31)	0.42 (0.36-0.50)
Expenditure	0.66 (0.55-0.80)	0.84 (0.73-0.97)
Outpatient		
# Encounters	1.12 (0.96-1.32)	0.98 (0.86-1.11)
Expenditure	1.58 (1.27-1.97)	1.22 (1.03-1.46)
Emergency Dept.		
# Encounters	0.10 (0.07-0.16)	0.21 (0.16-0.28)
Expenditure	0.17 (0.12-0.24)	0.27 (0.21-0.34)
Medicare		
	Avg. Pain Episodes vs. High Pain Episodes	Ab. Avg. Pain Episodes vs. High Pain Episodes
Total Expenditure	0.91 (0.79-1.04)	0.92 (0.82-1.03)
Inpatient		
# Encounters	0.58 (0.53-0.63)	0.65 (0.60-0.70)
Expenditure	0.90 (0.79-1.03)	0.94 (0.84-1.05)
Outpatient		
# Encounters	1.00 (0.85-1.18)	0.89 (0.78-1.03)
Expenditure	1.56 (1.22-2.00)	1.32 (1.06-1.63)
Emergency Dept.		
# Encounters	0.16 (0.13-0.20)	0.27 (0.23-0.32)
Expenditure	0.20 (0.16-0.25)	0.26 (0.22-0.31)

Avg. Pain Episodes: second quartile of annual number of pain episode encounters; Ab. Avg. Pain Episodes: third quartile of annual number of pain episode encounters; High Pain Episodes: highest quartile of annual number of pain episode encounters